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A REVIEW OF THE EXPERIMENTAL INVESTIGATION OF THE EFFECT OF FIBER REINFORCEMENT ON STRENGTH CHARACTERISTICS OF M30 GRADE OF CONCRETE

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Abstract - *This study aims to investigate how the inclusion of polyester and glass fibers influences the mechanical properties of concrete used in construction. Two different concrete mixes will be prepared, and varying amounts of fibers will be added to each mix. The compressive, split tensile, and flexural strength properties of the resulting fiber-reinforced concrete will be compared to those of conventional concrete. While it is anticipated that an increase in fiber content will correspond with a proportional increase in strength properties, it is important to note that beyond a certain percentage, strength may actually decrease.*

Both glass fiber and polyester fiber are commonly used in construction to improve the properties of concrete and prevent micro-cracks. In particular, alkali-resistant polyester fiber is suitable for use in pavement quality concrete (PQC) and overlays. The study aims to determine how different percentages of each fiber impact the compressive strength, flexural strength, and split tensile strength of concrete. It should be noted that while both fibers are effective at enhancing concrete properties, they may have differing effects on the final strengths of the concrete.

In summary, the addition of fibers to concrete can lead to improved mechanical properties, but it is crucial to carefully consider the percentage of fibers added to avoid diminishing returns. Finally, it is important to compare the effects of different fibers on concrete properties when choosing the appropriate fiber for a particular construction project.

Key Words: Glass Fiber , Polyester Fiber , Conventional Concrete , Fiber-Reinforced Concrete , Mechanical Properties , Micro Cracks , Compressive Strength , Flexural Strength , Split Tensile Strength.

1. INTRODUCTION

Fibers are commonly added to engineering materials, such as ceramics, plastics, cement, and gypsum products, to enhance their composite properties. This includes improving their tensile and compressive strength, elastic modulus, crack resistance, crack control, durability, fatigue life, resistance to impact and abrasion, shrinkage, expansion, thermal characteristics, and fire resistance.

While concrete is a versatile material that can be adjusted by changing its ingredients, including cementitious material, aggregate, water, and special additives. Despite its versatility, concrete also has some drawbacks, such as low tensile strength, poor post-cracking capacity, brittleness, limited ductility, low fatigue life, inability to accommodate significant deformations, and low impact strength.

Plain concrete is inherently weak due to the presence of micro cracks at the interface between the mortar and aggregate. However, this weakness can be overcome by incorporating fibers into the concrete mix. These fibers, which may be made of materials commonly used in composite materials, enhance the concrete's toughness and ability to resist the growth of cracks by distributing loads at internal micro cracks. The resulting material is known as fiber-reinforced concrete (FRC), which is essentially a composite material comprising regular concrete or mortar reinforced with small fibers. FRC is commonly used in applications where high strength and durability are required, such as industrial floors, bridges, tunnels, and airport pavements. The choice of fiber type and amount depends on the specific application and the desired properties of the FRC.

The presence of fibers in fiber-reinforced concrete (FRC) helps to transfer loads to internal micro cracks, which enhances the material's mechanical properties. FRC is a cement-based composite material that has gained popularity in recent years due to its excellent characteristics, including high flexural tensile strength, resistance to spalling, impact resistance, and superior permeability and frost resistance. The incorporation of fibers into the concrete mix is an effective way to improve its toughness, shock resistance, and resistance to plastic shrinkage cracking. These fibers offer numerous benefits to the material and contribute to its overall strength and durability.

1.1 Ceramics

Incorporating fibers, such as silicon carbide or alumina, into ceramics can increase their strength, toughness, and fracture resistance. This is because the fibers act as reinforcements and prevent cracks from propagating through the material.

1.2 Plastics

Adding fibers, such as carbon or glass fibers, to plastics can increase their stiffness, strength, and toughness. This is because the fibers add strength and rigidity to the plastic matrix, making it more resistant to deformation and damage.

1.3 Cement and gypsum products

Incorporating fibers, such as steel or synthetic fibers, into cement or gypsum products can improve their crack resistance, durability, and impact resistance. The fibers help to distribute stresses more evenly throughout the material, reducing the risk of cracking and increasing its toughness.

1.4 Fiber Reinforced Concrete

Fiber Reinforced Concrete (FRC) is a type of concrete that incorporates fibrous materials to enhance its structural strength. The fibers used in FRC are short, discrete fibers that are evenly dispersed and randomly aligned throughout the concrete matrix. Common fiber materials include steel, polyester, glass, and natural fibers. The characteristics of FRC vary depending on the type of concrete, fiber material, fiber geometry, distribution, orientation, and density used. The addition of fibers to concrete can effectively mitigate crack formation at both macro and micro levels.

Types of fibers:

The following are the different type of fibers used in concrete:

(a) Steel fiber

(b) Glass fiber

(c) polyester fiber

(d) Carbon fiber

1.4.1 Polyester Fiber Reinforced Concrete (P.R.C)

Polyester Fiber Reinforced Concrete (P.R.C) is a type of concrete that incorporates short, discontinuous polyester fibers into the mixture. These fibers are typically added in small amounts, typically around 0.1% to 0.5% of the total volume of the concrete.

The addition of polyester fibers to concrete can improve its mechanical properties, such as its strength, toughness, and durability. The fibers act as a reinforcement, helping to distribute stresses throughout the concrete and preventing cracking and other types of damage.

In addition to its mechanical properties, P.R.C. also has other benefits. It can be easier to work with than traditional concrete, as the fibers help to reduce the amount of shrinkage and cracking that can occur during the curing process. It can also be more resistant to corrosion and other types of damage, making it ideal for use in harsh environments.

P.R.C. can be used in a variety of applications, including building construction, road and bridge construction, and in precast concrete products. It is typically used in combination with other types of reinforcement, such as steel rebar or wire mesh, to create a strong, durable concrete structure.

1.4.2 Glass Fiber Reinforced Concrete (G.R.C)

Glass Fiber Reinforced Concrete (G.R.C) is a type of concrete that incorporates fine glass fibers into the mixture. The glass fibers are typically added in the form of chopped strands or woven mats, and are dispersed throughout the concrete matrix.

The addition of glass fibers to concrete can enhance its mechanical properties, such as its tensile strength, flexural strength, and impact resistance. The fibers help to distribute stresses throughout the concrete and prevent the formation of cracks and other types of damage. Additionally, it is highly resistant to corrosion and weathering, making it ideal for use in harsh environments.

G.R.C. can be used in a variety of applications, including building facades, cladding, decorative elements, and sculptures. It is typically used in thin sections, as the fibers are not as effective in larger sections.

2. LITERATURE REVIEW

[2.1] Study Of Glass Fiber Reinforced Concrete – (2010)

Authors **:** Gaurav Tuli et.al

The paper highlights that the addition of glass fibers in certain percentages improves the strain properties, crack resistance, ductility, flexural strength, toughness, and modulus of elasticity of concrete. While most research in fiber reinforced concrete has been devoted to steel fibers, glass fibers have recently become available, which are free from the corrosion problem associated with steel fibers. It is often combined with other composites such as plastic or carbon fiber to enhance its strength, reduce thermal expansion and increase corrosion resistance.

The study used CEM-FILL anti-crack, high dispersion, alkali-resistant glass fibers of diameter 14 microns with an aspect ratio of 857 in percentages varying from 0.33 to 1% by weight in concrete. The results showed that the modulus of elasticity of glass fiber reinforced concrete increased by 4.14% compared to conventional reinforced concrete.

Moreover, the addition of glass fibers resulted in a 5.19% increase in flexural strength and a 37% increase in compressive strength of various grades of glass fiber concrete mixes compared to 28 days compressive strength. The research also indicated that only a small volume of glass fiber is required, up to 0.33% of the weight of cement content. Further addition may decrease the strength of concrete.

[2.2] POLYESTER FIBER IN THE CONCRETE AN EXPERIMENTAL INVESTIGATION – (2011)

Authors：Venu Malagavelli et.al

The study investigated the use of non-biodegradable waste, specifically polyester fibers, in concrete to enhance crack resistance and strength. A concrete mix with a compressive strength of 25MPa was utilized, and samples were created using various fiber contents ranging from 0% to 6%, with an increment of 0.5%. The compressive, split tensile, and flexural strengths of the modified concrete were evaluated at different ages (3, 7, 14, 21, and 28 days). The results indicated that the strength of the concrete increased with the percentage of fiber up to 3.5% and then decreased up to 6%. The maximum deflection was observed for the modified concrete with 6% fiber, with a value of 1.16mm, whereas the concrete with 3.5% fiber exhibited a maximum deflection of 0.82mm. The utilization of polyester fibers in concrete can minimize non-biodegradable waste and increase the strength of the concrete. The modified concrete exhibited a 36.2%, 24.3%, and 15.13% increase in compressive, split tensile, and flexural strengths, respectively, compared to conventional concrete at 28 days. Furthermore, the load-carrying capacity of fiber-reinforced concrete beams was higher. It is recommended that the percentage of polyester fibers in concrete be limited to 3.5% from a strength perspective and 6% from a disposal perspective.

[2.3] FATIGUE PERFORMANCES OF GLASS FIBRE REINFORCED CONCRETE IN FLEXURE-(2011)

Authors : Yan Lv et.al

A study was conducted to evaluate the fatigue performance of glass fiber reinforced concrete (GFRC) under flexural fatigue loading at various stress levels. The study found that GFRC exhibited better fatigue resistance compared to plain concrete. To determine the fatigue-lives of GFRC at different stress levels, 63 beam specimens of size 100X100X400mm, incorporating 0.6%, 0.8% and 1% glass fiber volume fraction, were tested under four-point flexural fatigue loading by a universal testing system. The statistical distribution of GFRC's fatigue-life was found to be in agreement with the two-parameter Weibull distribution. The coefficients of the fatigue equation were determined for GFRC corresponding to different survival probabilities, allowing for the prediction of flexural fatigue strength for desired levels of survival probability. The findings of the study suggest that the fatigue performance of GFRC is superior to plain concrete.

[2.4] ANALYSIS OF POLYESTER FIBER REINFORCED CONCRETE SUBJECTED TO ELEVATED TEMPERATURES –(2013)

Authors : Siddesh pal et.al

The paper discusses the problem of steel corrosion leading to the deterioration of concrete structures at high temperatures. The use of fiber reinforcement with materials like polyester is suggested as a potential solution for creating durable repair materials that meet several criteria, including low shrinkage, good thermal expansion, and high tensile strength. The bonding between the fibers and concrete is crucial, and little is known about the effect of fiber percentage on properties such as flexural and compressive strengths.

The study shows that the compressive strength of polyester fiber reinforced concrete decreases with increasing temperature. The reduction in strength is more significant at higher temperatures, and the addition of fibers also leads to a decrease in compressive strength. Similarly, ultrasonic pulse velocity values decrease with increasing temperature and fiber percentage, with a more drastic decrease observed for specimens containing 0.5% and 1% fibers.The study also found that specimens containing 1% fiber mix showed lower surface temperatures than those containing 0.5% and 0% fiber, indicating that increasing fiber percentage can help the specimen withstand high temperatures and remain cool. Overall, the study highlights the potential benefits of fiber reinforcement for creating durable repair materials for concrete structures subjected to high temperatures

.[2.5] STRENGTH AND FIRE RESISTANCE PROPERTIES OF GLASS FIBRE REINFORCED CONCRETE – (2013)

Authors : C. Selin Ravikumar et.al

A study was conducted to investigate the mechanical properties of glass fiber reinforced concrete. The addition of glass fibers increased the strength of the material by increasing the force required for deformation and improving toughness by increasing the energy required for crack propagation. The study also found that glass fiber concrete has better fire-resistant properties compared to normal concrete. Over the years, the use of fibers in concrete has increased significantly for enhancing properties such as tensile strength and ductility. Glass fiber is a recent introduction to the field of concrete technology and has advantages such as higher tensile strength and fire resistance. In this investigation, glass fibers with a length of 450 mm were added to concrete up to a volume fraction of 1% to determine their strength and fire-resistant characteristics. The study compared the strength and fire-resistance performance of conventional concrete and glass fiber concrete.

The study concluded that with 0.5% addition of glass fiber, there was a 13% increase in compressive strength, a 42% increase in flexural strength, and a 20% increase in split tensile strength compared to conventional concrete. With 1% addition of fiber, the increase in compressive strength was determined.

[2.6] GLASS FIBRE REINFORCED CONCRETE USE IN CONSTRUCTION – (2013)

Authors: N . Shakor et.al

Glass-fibre reinforced concrete (GRC) is a cementatious material composed of cement, sand, water, and admixtures, in which short length glass fibres are dispersed. GRC is widely used in the construction industry for non-structural elements due to its lightweight, fire resistance, good appearance, and strength. It can be used for high-rise building construction panel, decorative panels, and even for the production of new products like composite walls and flooring. In a study conducted to indicate the differences in compressive strength and flexural strength by using cubes of varying sizes, trial tests for concrete with glass fibre and without glass fibre were conducted. The results showed that 1.5% of glass fibres used in concrete gave maximum 7 days average compressive strength. At lower or higher percentages, a reduction in strength of about 15% to 20% was observed, although the reduction reduced by 5% to 10% after 28 days. Increasing the weight of glass fibre in normal concrete affects the cohesiveness between the particles of concrete, resulting in the degradation of compressive strength, flexural, and tensile strength. For M60 mix, a percentage of glass fibre of 2% gave a flexural strength of 6.15 MPa, which is 10% more than that obtained at 1.5%. However, glass fibre does not affect high-performance concrete, especially if it contains a large gradation of coarse concrete because it leaves more porosity and spaces between the particles and allows air to move between. During mixing with concrete, care should be taken with glass fibre as it should not be mixed for more than 1 minute, otherwise, it will break into tiny pieces and cannot be worked with. Overall, the study indicates the tremendous potential of GFRC as an alternative construction material.

[2.7] COMPRESSIVE BEHAVIOUR OF POLYESTER FIBER REINFORCED SUBJECTED TO SUSTAINED ELEVATED TEMPERATURE – (2014)

Authors: Narayana Suresh et.al

The study investigated the effects of polyester fiber reinforcement on normal-strength concrete structures exposed to sustained elevated temperatures ranging from 100 to 800 degrees Celsius for 2 hours. A total of 72 specimens were prepared, consisting of 0%, 0.5%, and 1% volume fractions of 12mm polyester fibers in a 150mm concrete cube with a water-cement ratio of 0.475 and a mix of M20. The addition of fibers to the mix contributed to delaying the failure of the structure when exposed to temperatures between 25 and 400 degrees Celsius. The results showed an increasing trend in the residual compressive strength of normal-strength concrete up to a sustained elevated temperature of 400 degrees Celsius with the addition of 0.5% volume fraction of polyester fibers. The hand-mixing factor had a significant impact on the residual compressive strength of fiber-reinforced concrete. The study concluded that 0.5% volume fraction was the optimal dosage of polyester fibers, despite a decrease in concrete workability, providing better resistance to residual compressive strength reduction at sustained elevated temperatures.

[2.8] STUDY OF STRENGTH PROPERTIES OF POLYSTER FIBER REINFORCED CONCRETE –(2016)

Authors: U. Bhavitha et.al

The experiment investigated the effect of adding polyester fiber to concrete mixes of M25 grade at varying percentages of weight of the cement (0.25%, 0.5%, 0.75%, and 1%). The goal was to determine the optimal percentage of fiber addition that would improve the strength properties of the concrete, including compressive strength, split tensile strength, and flexural strength. Fiber Reinforced Concrete (FRC) is a relatively new construction material that consists of conventional concrete reinforced by randomly dispersed short length fibers of specific geometry made of steel, synthetic (polymeric) or natural fibers. The addition of fibers helps to modify the low tensile strength, brittleness, and low strain at fracture of plain cement concrete, making it stronger and more ductile.

The study used Recron 3s polyester fiber and found that adding 0.25% and 0.5% by weight of cement in the mix design increased the compressive strength by 16.20% and 6.80%, respectively, compared to the control mix.

The optimal percentage of fiber addition varied for each strength property, with 0.25% being the best for compressive strength, 0.75% for split tensile strength, and

0.5% for flexural strength. Overall, the study demonstrated that adding polyester fiber can improve the strength properties of concrete, but the optimal percentage of fiber addition depends on the specific strength property being targeted.

[2.9] EXPERIMENTAL STUDIES ON FIBRE REINFORCED CONCRETE – (2016)

Authors: E Arunakanthi et.al

The purpose of this study was to investigate the effects of glass fiber and steel fiber on the strength of concrete. The addition of fiber reinforcement to concrete can improve its tensile strength and fire resistance. In this study, M20 grade concrete was used with a mix proportion of 1:1.96:2.63 and a water-cement ratio of 0.45. The fiber reinforcement was added at percentages of 0%, 0.5%, 1%, 2%, and 3%. The compressive strength, flexural strength, and split tensile strength were measured after 28 days. The results showed that there was no significant difference in strength and ultimate compression capacity between the addition of 0.5% and 1.2% fiber reinforced concrete (FRC) for M20 grade concrete. However, there were significant differences in flexural strength and split tensile strength between the different types of FRC used. The percentage increase in strength was observed for each fiber reinforcement percentage at 28 days.

[2.10] PERFORMANCE OF EXTRUDED POLYESTER FIBER REINFORCED CONCRETE – (2016)

Authors: Y.M. Ghugal et.al

An experimental investigation was conducted to study the effects of extruded polyester fibers on various strengths of concrete. The fiber content was varied from 0.5% to 5% by weight of cement, and a concrete mix with a compressive strength of 40 MPa and a water-cement ratio of 0.37 was used. Tests were conducted on specimens of different sizes, including cubes for compressive strength, beams for flexural strength, and cylinders for split tensile strength. The specimens were cured for 7 and 28 days and then tested. Workability was measured using the slump cone test, and wet and dry densities were obtained. The results showed that as fiber content increased, workability and wet density decreased, but improvements in various strengths were observed, although not significant. The load deflection behavior showed improved ductility of the composite, and very good crack control was observed at 5% fiber content. The elastic constants were found to be within the normal range. The study concluded that the addition of extruded polyester fibers in concrete could improve its strength, durability, and crack resistance.

[2.11] EXPERIMENTAL INVESTIGATION ON UTILIZATION OF POLYESTER FIBER FOR IMPROVED PROPERTIES OF CONCRETE – (2016)

Authors: Vaibhav Shirodhar et.al

The study aimed to enhance the tensile strength and flexural strength of concrete, which is generally weak in tension but strong in compression, by adding different percentages of polyester fibers. The fiber percentages considered were 0.2%, 0.4%, and 0.6% by weight of cement, and the concrete used in the investigation had a compressive strength of 20 MPa and a water-cement ratio of 0.3. The study focused on determining the crack resistance, split tensile strength, and maximum strength that can be achieved by the addition of fibers. The results showed that the addition of 0.4% fiber gave the highest increase in compressive strength, split tensile strength, and flexural strength compared to concrete with 0% fiber. Overall, the investigation aimed to determine the effect of polyester fibers on the strength properties of concrete and to find the optimal percentage of fibers to improve its tensile and flexural strength.

[2.12] COMPARATIVE STUDY ON STRENGTH BETWEEN POLYESTER FIBER AND GLASS FIBER IN CONCRETE MIX – (2016)

Authors: S. Charan Raju et.al

This paper presents an experimental study that investigates the effects of adding polyester and glass fibers to M30 grade concrete with OPC 53 grade cement and a water-cement ratio of 0.5. The percentages of fibers added range from 0.1% to 0.4% for polyester fiber and 0.1% to 0.3% for glass fiber, and the results are compared with a mix that contains 0% fibers. The study concludes that the optimum percentages for achieving maximum compressive strength, split tensile strength, and flexural strength are 0.3% for polyester fiber and 0.2% for glass fiber. Any percentages beyond these values lead to a decrease in strength parameters.

[2.13] STRENGTH CHARACTERISTIC STUDY OF POLYESTER FIBER REINFORCED CONCRETE – (2018)

Authors: Alex Tharun PJ et.al

In this study, the use of polyester fibers and fly ash in concrete was investigated. The addition of fibers in different percentages (0% to 1%) to a concrete mix made of M30 grade cement with a water-cement ratio of 0.4 improved the properties of the concrete, such as compressive strength, tensile strength, impact strength, and abrasion resistance. The fibers provided support to the concrete in all directions and prevented corrosion.

The use of fly ash as a sustainable material in the concrete industry reduced carbon dioxide emissions, as it replaced some of the cement in the mix. The workability of the concrete decreased with an increase in fiber content, as seen in the slump value and compression factor. However, the addition of polyester fibers increased the compressive strength by 21.5%, split tensile strength by 65.5%, and flexural strength by 66.66%. The impact ductility index also increased with an increasing fiber content due to high bonding of the fiber. The replacement of fly ash created an economical and workable mix.

[2.14] STEEL AND GLASS FIBRE REINFORCED CONCRETE: A REVIEW- (2018)

Authors: Er. Lakshita Gupta et.al

This paper discusses the application of glass fiber reinforced concrete (GFRC) to minimize damage during fire accidents and its potential for creating sheet piling, head walls, and other passive elements. The study shows that GFRC can reduce damage by up to 30% compared to conventional concrete, thereby increasing its service life. The paper identifies the challenges of using conventional concrete and the potential of steel and glass fiber reinforcement in mix design to address them. The addition of these fibers enhances the compressive, tensile, and split tensile strength of concrete, with glass fibers providing high tensile strength and fire-resistant properties, while steel fibers improve flexural toughness, energy absorption capacity, ductility, and durability. The review concludes that replacing cement with glass and steel fibers can increase concrete's fundamental properties, but only up to a certain percentage to prevent a loss of strength.

However, the use of fibers reduces concrete workability, so their application must be limited. The study also observed improved surface integrity and reduced bleeding in most cases of fiber reinforced concrete. Finally, the addition of steel fibers improves the brittleness of concrete more than glass fibers.

[2.15] Glass Fibre reinforced concrete –(2018)

Authors: Muhammed Iskender et.al

This paper discusses the benefits of adding fibers to concrete mixes, specifically glass fibers, which can improve the material's resistance to wear and tear, permeability, and atmospheric effects like corrosion. Glass fiber reinforced concrete (GFRC) is a versatile building material that is lightweight, strong, fire and weather resistant, impermeable, and aesthetically pleasing. GFRC's physical and mechanical properties depend on the quality of materials and production methods. The addition of glass fibers can increase compressive strength and flexural strength, but excessive amounts can reduce workability. GFRC has a longer service life than traditional concrete due to its ability to control micro-crack propagation and its lower permeability.

However, glass fibers have a positive effect on the stress-strain curve and flexural strength of GFRC due to the increase in aspect ratio of fibers, resulting in an increase in pull-out and energy absorption of the GFRC .Although GFRC can be more expensive than traditional concrete, advances in technology may change this in the future. GFRC is widely used in architecture, building, and engineering applications and can be produced in complex forms and decorative materials using digital technologies. More research is needed to further improve the properties of GFRC.

[2.16] HIGH PERFORMANCE GLASS FIBRE REINFORCED CONCRETE – (2020)

Authors: Dinesh Kumar et.al

The study investigated the use of glass fibers in concrete to improve its mechanical properties such as compressive strength, flexural strength, and durability. The researchers experimented with different variations of Glass Fiber Reinforced Concrete (GFRC) mixed with concrete of grade M20 and M30 as per IS 10262:2009 and IS 10262:2000, respectively. For M20 grade concrete, the study focused on reducing the water content from 0% to 20% and adding glass fiber in three different percentages of 0.33%, 0.67%, and 1% to evaluate the effect on compressive strength and workability. The results showed that the compressive strength of concrete moderately increased for 7 and 28 days with the addition of 0.33% of glass fiber, achieving 19.23 N/mm2 and 41.32 N/mm2, respectively.

Moreover, the flexural strength of M20 with 1% glass fiber gradually increased to 14.5 N/mm2 and 18.8 N/mm2 at 7 and 28 days, respectively. The study also examined the effect of plastizer on compressive strength and workability of the concrete. Overall, the investigation aimed to evaluate the effective utilization of glass fiber on concrete and its potential to enhance its mechanical properties.

3. CONCLUSION

Based on the literature review, it can be concluded that adding fibers to concrete can improve its properties, including strength, durability, crack resistance, and impact and abrasion resistance. The use of specific fibers was found to be effective in achieving higher strength at early stages compared to conventional concrete.

However, it was also found that the strength of fibers decreases as the percentage of fibers increases. The performance of fiber-reinforced concrete is influenced by fiber geometry, volume fraction, and aspect ratio.

Additionally, while the initial cost of using fiber-reinforced concrete may be higher, the long-term cost savings from reduced maintenance and rehabilitation may make it a more financially viable option in the long run.

Future research should explore the optimal percentage and mix designs for different scenarios while considering economic factors. The majority of the reviewed studies used 1 to 6% of fibers with an increment of 0.5% to determine the optimum value for strength properties. These findings encourage further exploration of fiber addition to concrete by academics and construction engineering practitioners.

4.REFERENCES

[1] Gaurav Tuli , Ishan Garg , "Study Of Glass Fiber Reinforced Concrete" in IOSR journal of mechanical and civil engineering(IOSR-JMCE) , p-ISSN:2320-334X , june 2016.

[2] Venu Malagavelli , Neelakanteswara Rao Paturu , "Polyester Fibers in the Concrete an Experimental Investigation" in Trans Tech Publications , 2011.

[3] Yan Lv, He-ming Cheng , Zhi-guang Ma , "Fatigue performances of glass fiber reinforced concrete in flexure" in ELSEVIER , 2012.

[4] Siddesh Pai' , Kaushik Chandra. L , "Analysis Of Polyester Fibre Reinforced Concrete Subjected To Elevated Temperatures" in International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (LJCSEIERD) 2013.

[5] C. Selin Ravikumar , T.S. Thandavamoorthy , "Glass Fibre Concrete: Investigation on Strength and Fire Resistant Properties" in IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684.p-ISSN: 2320-334X, Volume 9, Issue 3 (Sep. - Oct. 2013), PP 21-25.

[6] Eng. Pshtiwan N. Shakor , Prof. S. S. Pimplikar , " Glass Fibre Reinforced Concrete Use in Construction " in International Journal of Technology And Engineering System(IJTES): Jan-March 2011.

[7] Narayana Suresh , Vivek Bindiganavile , Mahesh Prabhu , " Compressive Behaviour of Polyester Fiber Reinforced Concrete Subjected To Sustained Elevated Temperature " in International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-245, ISO 9001:2008 Certified Journal, Volume 4, Issue 8, August 2014).

[8] U Bhavitha , Mohammed Safiuddin , " Study of Strength Properties of Polyster Fibre Reinforced Concrete " in Journal for Research | Volume 02 | Issue 08 | October 2016 Issn: 2395-7549.

[9] E. Arunakanthi , " Experimental Studies On Fiber Reinforced concrete (FRC) " in International Journal of Civil Engineering and Technology (IJCIET) Volume 7, Issue 5, September-October 2016, pp. 329-336.

[10] Y. M. Ghugal , S.V. Naghate , " Performance of extruded polyester fiber reinforced concrete " in Journal of Structural EngineeringVol. 43, No. 3, August-September 2016 , pp. 247-257.

[11] Alex Tharun PJ , Nishma V Mohan , Aswathy LS , Sruthy Sreekumar , Aparna A V , " Strength Characteristic Study of Polyester Fiber Reinforced Concrete " in International Journal of Engineering Research & Technology (IJERT) , ISSN: 2278-0181 , 2018.

[12] Er. Lakshit Gupta , Er. Harpreet Singh , " Steel and Glass Fibre Reinforced Concrete: A Review " in International Research Journal of Engineering and Technology (IRJET) , e-ISSN: 2395-0056 p-ISSN: 2395-0072 , Feb-2018.

[13] Muhammed İSKENDER , Bekir KARASU , " Glass Fibre Reinforced Concrete " in ECJSE , ISSN:2148-3736 , 2018.

[14] Dinesh Kumar , LK. Rex , V.S. Sethuraman , V. Gokulnath , B. Saravanan , " High performance glass fiber reinforced concrete " in ELSEVIER , 2020.

[15] S. Charan Raju , Ch. Vinodh Kumar , K. Bhanuji Rao , G. Himala Kumari , " Comparative Study On Strength Between Polyester Fiber And Glass Fiber In Concrete Mix" in International Journal For Technological Research In Engineering , SSN (Online): 2347 – 4718 , August-2017.

[16] Vaibhav Shirodkar , Manasi Lolienkar , " Experimental investigation on Utilization of Polyester Fiber for Improved Properties of Concrete " in IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , e-ISSN: 2278-1684, p-ISSN : 2320–334X , PP 01-04 , December 2016.

[17] S.A kanalli , Ramupalankar , Bharat kumar , Praveen kumar , Prakash S.K, "Comparitive study of polymer Fiber reinforced concrete with conventional concrete" in URET, 2014.

[18] C. Selin Ravi kumar , T.S. Tandavamoorthy , "Glass fiber concrete: investigation on strength and fire resistant properties" in IOSR-JMCE, 2013.

[19] Yogesh lyer Murthy, apoorvshanda, Gouravjain , "Perfomance of Glass fiber Reinforced concrete" International journal of Engineering and Innovative Technology Volume 1, Issue 6, june 2012.

[20] Indrajt Patel, CD Modherav. "Study effect of polyester fibers on engineering properties of high volume fly ash concrete" , in Journal of engineering research and studies.